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TellEat: Sharing Experiences on the Move

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Abstract. In a context where, due to the proliferation of mobile devices, virtual social environments on the Web are taking up a very concrete role in the way people experience their surroundings, the Future Internet seems to be headed toward a mixture of Social Web, Semantic Web and Augmented Reality. As a part of a larger project that aims at building a social network of both people and things, we designed and developed TellEat, an iPhone-based application that allows users in mobility to share facts concerning people or objects that participate in the social network, and to discover pertinent events that have been told by others. In this paper we discuss both the client application, with the interaction model and interface metaphors that have been designed to make the experience as playful as possible for users, and the server-side services that provide the necessary knowledge and reasoning mechanisms. We also present the results of preliminary tests with users.

1 Introduction

Communication and technology are moving out from offices and home environments into the outside world. Due to the proliferation of mobile devices, people have uninterrupted Internet connection and constant access to information in virtually any situation. As a consequence, virtual social environments (as for example social networking services) on the Internet are taking up a very concrete role in the way people experience and interact with their surroundings. In other words, the perception of what *is real* starts to include elements of the virtual world, blurring the distinction between “the real” and “the virtual”.

Within this context, the bridging of the Social Web, the Semantic Web [12] and Augmented Reality [1] has become a feasible and interesting option. The Social Web brings together people, creates and maintains relationships, facilitates the sharing of contents. The Semantic Web organizes and gives a structure to the information provided by users, allowing for better search and retrieval mechanisms, and allowing for inferences on user-provided content based not only on the relationships between users (as in basic social networking services) but also on semantic relationships between the objects that the users discuss or comment about. Augmented Reality provides enhanced interaction with physical objects, by endowing them with Web-based counterparts accessible through

mobile devices at the same time as their physical self is. This allows users to discover additional information about their physical environment, but also to act upon it as they would do in a social networking service: tagging, commenting, posting content, and recommending to other users.

The PIEMONTE¹ project has investigated and implemented the notion of a *social web of intelligent things*, where augmented physical objects actively participate in a social network by creating relationships among themselves or users, and by sharing knowledge. Friendships between objects are established by reasoning on their semantic relations, represented by a domain ontology, and by mining users' activity in the social network. This framework is being implemented and tested in the field of traditional gastronomy, with the goal to promote the cultural heritage of the involved territory (the Piedmont region in the north-west of Italy). As a part of this project, the WantEat suite of applications [7] has been developed. The mobile application in WantEat allows users to browse the enhanced social network starting from the objects they have at hand, navigating their relationships and thereby discovering the territory they come from, or are visiting. With WantEat, users can perform social actions (tagging, rating, etc.) on objects they are browsing.

Within this framework, we proposed an approach to foster collective storytelling [14], devising a structured language and representational form to describe users' story fragments, investigating measures that capture similarity [6] and pertinence relations between them, and studying linking patterns that can be used to thread fragments into story-like narratives.

Starting from these ideas, we designed and developed TellEat, an iPhone[™]-based application that allows users to provide the system with a fact, concerning people or objects in the WantEat network, and to discover pertinent events told by others. A significant effort has been devoted to developing interface metaphors and an interaction model suitable for the underlying representational language, while at the same time being intuitive and playful enough to be used in mobility. In addition, preliminary tests have been conducted in order to compare the inferences made by our algorithms with those made by humans.

The rest of the paper is organized as follows. Section 2 describes the general design of TellEat in the context of WantEat, followed by the description of the user interface with the interaction model designed for the Apple iPhone[™] (2.1) and the server-side architecture (2.2). Section 3 provides the results of the preliminary tests carried out with users. In section 4 some relevant literature is discussed, while section 5 points to future developments.

2 TellEat

The TellEat application has been developed as an add-on to the WantEat suite, which we briefly describe. The key ideas behind the WantEat suite are: (i) building and maintaining a social network of both people and things, (ii) allowing

¹ PIEMONTE Project - People Interaction with Enhanced Multimodal Objects for a New Territory Experience 2009-2013, <http://piemonte.di.unito.it/>

users to interact with things belonging to the social network in augmented reality, and (iii) turning things into hubs that connect users with a larger world. WantEat implements these notions in the domain of regional food and wine products. Users can have access to an object's augmented life thanks to *WantEat Mobile*, a client application for smartphones, including the Apple iPhoneTM. By framing labels, logos or signs with the smartphone camera [11], users can get in touch with a thing's avatar, and interact with it in the usual Web 2.0 fashion, providing ratings, tags or comments. They can also browse the “wheel” of an object's relations, explore its social network and obtain information on the object's territory. The social network connects producers, restaurants and shop owners, as well as products (cheeses, wines, vegetables, etc.) and places (shops, farms, restaurants, market stalls, etc.). Friendships between objects are established by reasoning on their semantic properties (e.g. two recipes with similar key ingredients), or by mining users' activity in the social network (e.g. two restaurants often bookmarked together) and user-generated content (e.g. a wine often mentioned in the comments on a cheese).

The goal of TellEat is to provide users with an additional way to share information with the system and other users. TellEat enables users to tell to the system what they did with a certain object. For example, they may have sipped a wine, brought it to a dinner party, or used it in a recipe. As a “reward” for telling something to TellEat, users get back a list of facts told by other people that the system reckons to be pertinent to the fact inserted by the user. This means that users can tell facts with the intent of querying the system for similar things happening to their friends.

Conceptually, TellEat is composed of the following modules (a more detailed description of the architecture and its implementation is given in 2.2).

- A **client app** for the Apple iPhoneTM, that allows users to interact with the system and share their contributions in a playful way.
- A **fact repository**: as described in [14], we represent facts in OWL, as instances in an ontology. Conceptually, each fact is a pair (p, F) where p is a chosen verb, representing the action, and F is a set of pairs (r_i, f_i) , representing the actors and their roles in the action. For each of these pairs, r_i is a role label chosen among *who*, *what*, *where*, *when*, *how*, *why*; f_i is the role filler which can either be an entity in the domain ontology of WantEat (person, thing, place, etc.) or a custom label defined by the user.
- A **pertinence module**, which evaluates the pertinence between a newly inserted fact and those existing in the repository. The measure of pertinence we use is introduced in [14] and is based on the friendship between involved people, on the colocation between facts (co-occurrence in space and time), and on semantic similarity between the mentioned entities, computed using the distance based approach proposed in [6].

2.1 The Client App: Interaction Model and User Interface

In order to build a fact (p, F) users need to provide the verb p and as many role fillers as they like for each of the six available roles. The choice of the verb is

restricted to the verbs present in our ontology; role fillers can be either entities (objects, places, people) that are present in the WantEat social network, or custom entries made of a label, a short description and an optional image.

For our interaction model we decided to use the metaphor of a letter: the fact is represented by an envelope, containing paper sheets for the different roles, in different colors, and with a stamp showing the chosen verb.

The user starts by selecting a verb, and then moves on to provide fillers for the roles; it is always possible to go back at any time if needed.

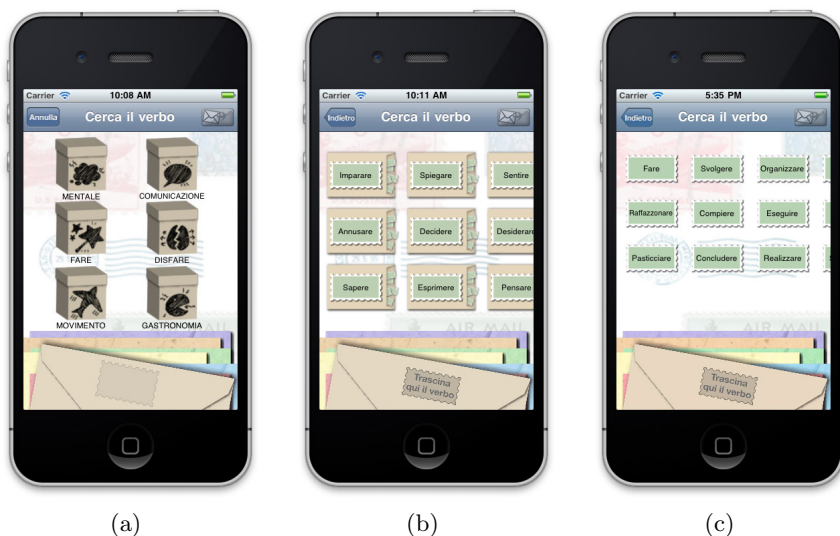


Fig. 1. (a) Verb categories (first level). (b) Key verbs (second level). (c) Verb variations (third level).

Figure 1 shows the phases of the verb selection process. Rather than showing the ontology structure, which would make it difficult for the user to find the desired verbs, the user interface shows verbs organized according to a three-level folder structure: the first level (Figure 1(a)) contains broad categories (e.g. *speech actions*); the second level (Figure 1(b)) contains key verbs for the category (e.g. *speak* or *talk*); the third level (Figure 1(c)) contains subtler variations of the verbs from the second level (e.g. *whisper*). A verb is selected by dragging the corresponding stamp on the envelope.

Once the verb has been chosen, the role filler selection phase takes place, as shown in Figure 2. Six paper sheets in different colors, one for each role (Figure 2(a)), appear from behind the envelope. This view serves as an overview of the given fact, where the user can see the verb and its roles at a glance; the sheets can be moved on the screen to better explore their contents. This view is also used to show to a user someone else's facts.



Fig. 2. (a) An empty phrase, (b) Suggestions in the envelope, (c) Creation of a new object

In order to *edit* a sheet's content, the user has to tap on it. The main screen for the role filler selection process is represented in Figure 2(b). Role fillers are represented as stickers (containing a picture or a label). A set of suggested role fillers is placed in the envelope (exploiting the recommendation service provided by WantEat); the user can either pick one of them, or search something in the WantEat domain. The search window provides also the option of inserting a custom label and/or picture and/or a short description (see Figure 2(c)) in case the desired object is not present in WantEat. However, in this case the object is not tied to the ontology and will not be interpreted by the system.

When the user has finished editing the fact, he/she can submit it by clicking on the send button at the top right of the screen. She will then get back a list of pertinent facts, which she can view one by one.

2.2 Server-Side Architecture

In order to achieve its goals, TellEat exploits services of WantEat and additional modules.

Figure 3 shows the server-side architecture, where services and modules that are TellEat-specific are distinguished by a thick black border. The figure also distinguishes three different interaction threads, numbered 1, 2 and 3, between the client application and the server.

Interaction 1 happens when the client application needs the available verbs. Since these are stored as an added part of the domain ontology, TellEat's *Coordination Manager* dispatches the query to the Fact Repository Module, that

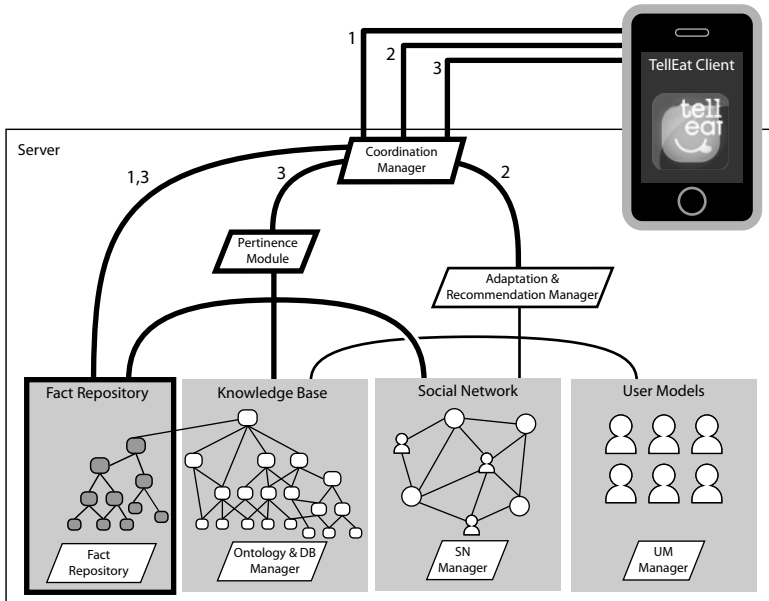


Fig. 3. Server-side architecture of TellEat

in turn queries the *Ontology & DB Manager* for the list of available verbs, and maps them to the three-level hierarchy in the client.

Interaction 2 happens when the client has to suggest role fillers to the user. This is achieved by using the support from the *Adaptation & Recommendation Manager* in *WantEat*, as well as by taking into account other things, such as a role type, other facts inserted by the user, etc.

Interaction 3 happens when the client submits a newly inserted fact. In this case, the fact is sent for storage to the *Fact Repository* module. After the fact has been inserted, its pertinence with other stored facts is computed by the *Pertinence Module*. Facts with a pertinence value above a certain threshold are then sent back to the client, to be shown to the user.

Fact Repository. Facts in TellEat are represented both as instances of a verb in the OWL verbs ontology and as records in a relational MySQL database, storing other information as creation date, ownership, notes, custom labels and pictures. The Fact Repository provides a homogeneous access interface to the facts synthesizing a uniform representation from these two heterogeneous data sources. In particular the D2RQ tool is used to view a part of a relational database as a set of OWL individuals [2] to provide a uniform virtual data source that can be directly queried in SPARQL.

Pertinence Module. The pertinence module computes the pertinence between facts according to the measure presented in [14]. We give a short overview of the

key ideas. In calculating pertinence between two facts, the following is taken into account:

- different facts use different predicates taken from the predicate ontology to express their content;
- each fact has only one predicate since every fact can be decomposed into more facts with only one predicate;
- each predicate has a set of associated values for different role fillers;
- each role might have 0 or more role fillers;
- the semantic similarity between two predicates or two role fillers is calculated using a measure presented in [6];
- co-location estimates the possibility for the actors to meet while performing the described actions.

Summing up, given two facts f and g , the *pertinence* of the fact g for the fact f is given by:

$$\text{PERT}(f, g) = \alpha_0 \text{SP} + \sum_{i=1}^m \alpha_i \text{SRF}_i + \beta \text{COLOC} \quad (1)$$

where SP is *semantic similarity of predicates*, $\text{SRF}_i, i = 1, \dots, m$ are *semantic similarities of role fillers* (m is the number of role fillers for f), COLOC is the *colocation* and $\alpha_0, \dots, \alpha_m, \beta \in \mathbb{R}$ are weights. To reduce redundancy, when calculating the similarity of role fillers, we consider only the pairs with maximum similarity values for each role filler. This allows to take into account only meaningful conceptual distances, not any type of vague resemblance between role fillers. In the special case where similarity is being calculated for two users, we use their social network relationship. The pertinence calculation can be enhanced by introducing weights for certain roles depending on the verb.

3 Evaluation

3.1 Goals of the Experiment

In this section we describe a simple preliminary evaluation which we conducted in order to evaluate the performance of our pertinence measure. Our main goal was to find out if the facts retained pertinent to a given fact by the system, are also viewed as pertinent by the users, since this would mean that the suggestions of our system could be interesting for users.

3.2 Description of the Experiment

We recruited a total of twenty subjects among our contacts and colleagues, according to an availability sampling strategy.² All were native Italian speakers. The test consisted of 5 identical steps. In each step, the subject of the test

² Even though non-random samples are not statistically representative, they are often used in psychology research and usability testing, during early evaluation phases.

was given one primary fact and a list of seven secondary facts. We chose the secondary facts from a range of facts having different values of pertinence with the primary fact according to our system. For example, for the primary fact

“At the party, Sonia and Lea shared a piece of cake made with Fuji Apples.”, the secondary facts could have been

“Sonia brought a cake made with Fuji Apples to a party.”,
as well as

“Dan tastes a cheese in his local store.” or

“Fred buys a book for his girlfriend’s birthday.”.

Also, the secondary facts were always presented in the random order. For each of the secondary facts, the subject was asked to assign the values on the 4-point scale from 0 to 3 (0 meaning not pertinent at all, 3 meaning very pertinent) depending on their perception of the pertinence of the secondary fact with the primary fact. Hence, each subject had to evaluate a total of 35 facts.

3.3 Results and Discussion

Given the subjective nature of pertinence evaluation by the users (context awareness, subjective importance of different roles, etc.) in a social context, the correct detection of the pertinent facts by the system is more important and interesting than the classification of non-pertinent facts. In a social system users expect to see positive results and the links between them.

To this aim, we decided to set a threshold value of $PERT = 2.0$ above which the secondary facts are considered pertinent, hence interesting, for users. This meant that for different primary facts the system offered between 1 and 4 pertinent secondary facts. These facts were considered pertinent by the users in 75% of the cases. When we raised the threshold to $PERT = 2.25$, the percentage of the facts perceived pertinent by the users was 76%.

This shows a satisfactory level of performance of our pertinence measure. On the other hand, while performing the evaluation, we learned a whole lot about human behavior in assessing pertinence between events. Some of the users were looking for cause-effect relationships, some were giving higher importance to friendship relationships between protagonists, some were valuing more the events etc. These findings provided us with valuable directions for future research and for fine tuning our application.

4 Related Work

A framework that tries to support users in mobility is described in [16]. Their “Story-To-Go” engine guides users through places of interest in a city. User-provided images and metadata, that are available at a certain location, are grouped together into so called hypespots which can be used in building a story. For each hypspot, a set of possible story directions is generated, which forms the building blocks for a future story. When the user starts a story, the story engine presents the related material covering different hypespots which fit into a reasonable time frame and cover reasonable search space.

Similarly, [10] proposes a storytelling application that can be used by people with aphasia (communication disorder caused by brain disease or injury). The prototype was implemented on a Tablet PC with an attached webcam. Their multimodal interface enables users to take photos, make drawings and record sounds in order to create their stories and express their feelings.

These applications focus on suggesting narrative possibilities, rather than truly providing information to users. Our proposal, in contrast, has at its center a single narrative fragment, and it can be seen as an evolution of Facebook³ status messages or comments. Although we are also ultimately interested in building stories from narrative fragments, we want fragments to be as similar as possible to what people communicate with each other over social networks.

InStory [8] is a project whose goal is the implementation of a client-server platform for mobile storytelling, information access and gaming activities. The client device is able to store users' positions and their actions and send the information to the server database. Moreover, the same users can upload different types of data (text, images, etc.) to integrate them with the system data and particularly, the story created by the system. In our framework the users have more possibility to express themselves and to add details, which can be used to connect together the stories of different people.

MIST [18] is a multimedia storytelling platform where various media types are combined into non-linear stories. The users can create, edit or read stories. Stories consist of elements containing structural information or media specific descriptions. Links between story elements are made using media files and their descriptions. MIST does not support the collaborative storytelling paradigm (each user can only create his/her own story). In [5] an extension of MIST, called PESE is proposed which takes into account Web 2.0 technologies. A user model is conceived where users with different roles can perform different media operations. In this framework many handheld clients can connect to a centralized server and subscribe to various stories at the same time.

INSCAPE [9,19] is an authoring environment for designing, creating and experiencing interactive stories and simulations. Users can design interactive storyboards, edit and visualize the story structure, create 2D and 3D scenes and characters, incorporate various multimedia, such as sounds, pictures and videos, and publish the stories on the Internet. Topological graphs are used to visualize stories where nodes are objects of the story and edges are interactive transitions or conditional relationships. We are devising a similar approach to connect facts into a story. However, INSCAPE is aimed at a different audience, and it provides a representation for story fragment atoms quite different from ours.

In [4] narrative presentation for lifelog archives containing large amount of data in different formats such as SenseCam diaries, photos, videos and text documents is described. According to the authors, the most used means to describe someone's experience is the visual content, while the other modalities are used to support the visual content. They also conclude that the nature of the story and the author's personal view of the story have a considerable impact on the

³ <http://www.facebook.com/>

fragments used for representing the story and the final outcome. In our framework the story fragments are also collected from heterogeneous sources and the users can freely chose and combine the available elements.

PoliCultura [3] is a project targeted at Italian school children which should enable the students of different age groups to design and construct interactive stories over a longer period of time. *1001stories* is a web-based authoring-delivery environment which enables children to combine images, text and mp3 files into interactive stories. The authors present their work as a platform encouraging *collective narratives*, but it seems that it is more similar to a system supporting *collaborative narratives*, where many authors collaborate in constructing a story. On the other hand, in our framework we try to enable real *collective narrative* construction where authors can work independently of each other when contributing their facts to the system and conceiving a story.

CultureSampo [13] is a semantic web portal for finnish cultural heritage. It incorporates multiple, nation wide collaboratively maintained ontologies for different domains and multiple metadata schemas. The semantic model is based on events and narratives and it provides the tools for collaborative content and ontology creation.

NetworkING [17] is a novel system for generating narratives in a medical drama domain based on the virtual characters' social network and the existing relationships among them. The user can change these relationships using a visual interface and generate new narratives. The experimental results prove that these changes do impact the diversity of produced narratives and less importance can be given to plot structure. The authors use Levenshtein string distance, similar to our pertinence measure, to compare the generated narratives.

5 Conclusions and Future Work

In this work we further develop the ideas presented in [14]. In particular, we describe the TellEat application, that allows mobile users of the Semantic Social Web to share narrative fragments called *facts*. In addition, we focus on an interaction metaphor and an interface design that provide users with a playful and intuitive way to build their own narrative fragments. The narrative fragments we are interested in are those that describe users' experiences with respect to the entities in the domain that the semantic framework describes, and that concern the theme of the Social Networking Application. Our work was in particular targeted to a Social Application about food and wine as a part of the cultural heritage of a territory.

Ultimately, the goal of our proposal is to allow automatic interpretation and correlation of the information provided by users. This idea can be expanded in several directions:

- Facts could be used in a similar way to tags, to describe or comment on specific resources (e.g. to describe the contents of an image). In this case, interpretation and correlation of facts may play a significant role in search and retrieval of information (e.g. queries of the form “People drinking wine”).

- Automatic extraction of story fragments from phrases expressed in natural language could facilitate and accelerate their gathering process.
- An intelligent repository of facts may exploit the user model present in the social network to show the users only the facts provided by other people that may be of interest to them (this can indeed be done with similar techniques as those adopted in recommendation systems [15]).
- In the type of social network we are considering, where objects are active social members, each object may collect the narrative fragments where it plays a role and use them to build a personal memory and a personalized presentation to the world.
- Since different users may have different perception of pertinence for facts, finding out what influences their choices and impressions and how to take all these factors into account could improve our proposal and reveal interesting correlations we might not be aware of.
- Last but not least, users may be encouraged to connect together several narrative fragments (whether their own or other people's) to form complete narratives. This possibility opens a way to a new storytelling paradigm, *collective storytelling* [14], where users can conceive and design stories independently of each other, however contributing to the same collective story.

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